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# THE REGAL LILY

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## DIFFICULTIES IN ACCUMULATING STOCKS

American experience with the Regal lily (*Lilium regale*) embodies a fine demonstration of the inherent difficulty connected with the establishment of a new crop. The species was discovered by E. H. Wilson in north-central China in 1903 and was introduced by him into the United States in 1908. In spite of the fact that it is a plant of the most easy culture and propagation, only now, after 18 years of optimism with reference to its possibilities, is the culture beginning to assume a commercial status. Even yet there are those who are skeptical about our ability to produce satisfactory bulbs in this country. This skepticism is due in largest measure to unsatisfactory experience with market materials which have been kept down in size and quality by excessive demands, lack of experience, and want of information.

We have here the anomaly of a market offering of only a few hundred thousand bulbs of all sizes, and a prospective demand in a very short while for a dozen millions if the bulbs were offered. The eager taking up of the stocks before the bulbs have time even to flower prevents the accumulation of propagating materials. The demand is so great and the prices so attractive that the tendency

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is to put smaller and smaller bulbs on the market. Of course this defeats its own ends and effectively keeps down production.

The tendency has been to turn into cash as soon as possible all the bulbs that can be gotten together from any source and to submit as small bulbs as the market will take. Of course supplies can not be worked up by such methods. Progress is difficult and slow when there is such a constant drain on the capital stock.

Coupled with commercial destruction has been the additional deterrent of inexperience in the culture. It has been necessary for growers to learn the handling of the lily, which is decidedly different from any other item they have ever produced. Above all, it has been necessary for them to learn, mostly by bitter and costly experience, that the most critical time in the history of any lily is the first winter. That the Regal, although less difficult to handle during this period than most lilies, is no exception has been proved by some very serious losses which have occurred.

## TIME OF SEED PLANTING

The Regal lily is preeminently one to be grown from seed (pl. 1, B), for reasons which will become apparent later on. There are other ways of propagating it, but no other method compares favorably in effectiveness.

The time was when the writer advised planting seed in autumn, for good success resulted for three years from fall planting; but finally there came a failure, owing, it may be, to the seed germinating and then being killed by a subsequent freeze. At all events, by spring the seed was rotted and no plants came up. Other growers have had similar experiences. Failures with spring plantings, properly tended, have not been experienced, and the consensus of opinion seems to be that planting as soon in the spring as the ground can be worked, or at the time vegetable seed is sown, is the safest and best time, all things considered. Some plantings, however, have succeeded admirably as late as the middle of June, and fall plantings commonly have not failed. On Puget Sound late August, September, and October plantings have all been successful, the seed in all cases germinating in the spring.

## SEEDING

If maximum development is looked for, the seed may be sown in flats early in November, transplanted into 2-inch pots or other flats late in January, and carried so until danger of frost is over in the spring. (Compare pl. 2, B, and pl. 3, A.) The plants are then taken out of the pots and set in the open ground, preferably in beds. If a 3-foot bed is planted, seven to nine bulbs will make a row across the bed and the rows can be 6 inches apart. If planted seven to the 6-inch row, the plants can remain without disturbance for two or even three years, or until the bulbs are about the full size of 6 inches or more in circumference.

Doubtless the most practical method of seeding on an extensive scale is to prepare a perfect seed bed under open-field conditions, where it is at all possible to do so, and plant the seed in beds. A

perfect seed bed should be prepared by deep plowing, thorough harrowing and fining, and if necessary hand raking, in order to get the surface in perfect condition. Of course, planting in the open in most sections, except the moist Pacific Northwest, presupposes some method of artificial watering to maintain suitable moisture conditions.

Under field conditions the seed should be put down 1 to 1¼ inches deep in any way the grower happens to fancy, as with any other crop. The writer's favorite method is to lay off the ground carefully and put the seed in with a garden drill. For this method it is necessary to run the rows lengthwise of the 3-foot bed, planting six 6-inch rows and then skipping one or two rows for the interbed space. Shallow trenches may be opened with the corner of a hoe and the seed distributed by hand and then covered with hoe or rake.

The thickness of the seeding will depend somewhat upon how the crop is to be handled. Generally four to six seeds to the inch give about the right amount of growth, when the normal failures and usual mortality due to accidents are taken into account.

In selecting the location for this kind of seed bed particular care should be taken to plant on ground that is as free of weeds as possible, because, excepting in the paths, the weeding must all be done by hand.

The beginner or the inexperienced grower who must conserve his seed supply and who is handling moderate quantities will usually plant in frames where conditions can be kept under better control. (Pl. 1, B.) Here still more attention can be given to soil preparation by deeper culture and the incorporation of a greater quantity of organic débris to increase percolation and moisture-holding capacity. In frame handling the depth of planting can be very much reduced. The seed can be sown practically on the surface of the smoothed bed and covered with only one-fourth inch of sifted earth of the ordinary composted mixture. This will not bake, provided, of course, that proper care be employed in watering.

In order to maintain suitable moisture conditions the surface of the planted frame may be covered with old burlap or any other coarse, open fabric laid on the soil after seeding. This will maintain an even moisture condition on the surface without the necessity of applying water so often. It should be removed as the plants come up, or, better still, elevated so as to furnish shade for a time.

In frame seeding the distance between the rows may be reduced to 4 or even 3 inches, the mulching can be more perfectly done, lath or other shade can be employed to advantage, and more accurate and effective use of fertilizer is practicable.

## CARE THE FIRST YEAR

In any frame or flat planting of seed the grower must keep a careful lookout for signs of damping-off, which is prone to occur with this and many other lilies. This condition may be prevented by always maintaining good aeration and withholding water. Keep the young plants on the dry side; water only in the morning, and then only when needed; be sure the plants go into the night dry and that the soil is decidedly on the dry side.

The condition and character of the soil in the flats or frames will influence very decidedly the ease with which the seedlings may be kept in condition to withstand the inroads of the damping-off fungus. It should be of such a nature that water passes through it quickly, and the general drainage of the frames or flats should be such that surplus water will pass through readily and out of reach of the plants in a few minutes.

In either frames or field it is most desirable that an effort be made as soon as the plants are up to do everything possible to keep the soil cool, and it should be of such a friable nature that stirring will not be necessary. This protection of the soil in the seedling bed is best accomplished by a mulch, and this must be of fine material. Chopped straw, chaff, well-weathered hardwood sawdust, fined woods soil, spent hotbed manure, peat, or even sharp sand over a clay loam would be beneficial.

In such a planting there is little opportunity for stirring the ground, and in fact stirring is not necessary or even advisable. Weeds must be pulled by hand, and no other form of culture than this is necessary. It is advisable to make a second application of mulch later in the season when the size of the plants permits.

Late in the fall of the first season, after the frost has seared most of the leaves, it is a good plan to put about 1 inch of soil over the beds. If the paths are wide enough the soil for the purpose may be taken from them, but it is better to haul it from some other place.

At first consideration it may seem a laborious process to carry the seedlings through this first season. Putting in the seed, hand weeding the beds through the entire season, applying a mulch possibly twice during the summer, and then covering the beds with soil in late fall may seem exceedingly burdensome. However, in actual practice it is less so than its discussion might indicate.

The beds used for such work at Arlington Experiment Farm, Rosslyn, Va., are 130 feet long. (Pl. 2, A.) In such a bed, 3 feet by 130 feet, at the rate of seeding recommended, a perfect germination would net over 50,000 seedlings. By estimate, based on counts of portions of rows, an actual crop of 30,000 lily plants has been raised on such an area. The work outlined is not excessive when the density of the crop is taken into consideration. The area of such a bed plus the 18-inch path is only 600 square feet, or about one-seventieth of an acre. It is believed that no efficient, effective, or satisfactory handling can be much cheaper or needs to be.

## LENGTH OF TIME IN SEED BED

Where frame seeding is practiced, the use of the seed bed for more than one season may not be practicable. Because of the necessity of economizing space the planting is very thick, and the plants will be too crowded the second year, resulting in poor bulb growth with a risk of damping-off of the foliage due to poor aeration. Doubtless a larger bulb development will also take place under most of the planting specifications given here if transplanting is done after the first year's growth.

Under field conditions and in large operations, on the other hand, it is possible that economy of time and effort may often favor leaving the stocks in the seed bed for two years. There is no doubt that a

larger bulb will result from transplanting and spacing the bulblets after one year's growth. Some economies are effected, however, by the two-year method. Saving the expense of handling, economy of space, more effective use of fertilizer, and decided economy of any mulching that may be done go a long way toward offsetting a somewhat increased growth that may be gained by spacing earlier. Again, it takes three growing seasons to make a first-sized bulb in outdoor planting, and this can be accomplished in the same time with the fewer handlings. But the transplanting can be done after the first year's growth and the stocks spaced to stand two years thereafter, and whether the stocks are left in the seed bed two seasons or in the first spaced planting for that length of time may not be especially important except in the economy of space and material. One transplanting by either method may serve to bring a batch of seedlings along so that the majority of them are merchantable, but transplanting at the end of the second year economizes in the protection of the stocks the first two years.

If seedlings are started inside and transplanted to the field seven to nine in each row, they can remain without disturbance for the full three-year period, provided that suitable fertility is maintained by a top dressing of rotted manure so applied as to serve the dual purpose of fertilizer and mulch.

## FALL OR SPRING PLANTING OF BULBS

The Regal lily will not make root or other growth at low temperatures. Moving in the spring rather than in the fall, as is done with some of the common species of lilies, is therefore advisable. If stocks are dug and reset after October little or no root action takes place until spring. The bulbs are buried in the soil and remain all winter without taking hold of the ground. It has been the writer's experience that especially in Virginia better success always accompanies spring planting, although no instance has occurred when the bulbs have been lost through fall planting. It is simply better for the lily and more in keeping with its habits to move it in the spring than in the fall.

When bulbs are merchandised, however, it is likely, on account of trade demands, that digging must be done in the fall when other lilies are put on the market and also when this one is needed, if bulbs are wanted for forcing. However this may be, it seems from the writer's experience that better growth is obtained if spring handling takes place, and it is believed that such practice is advisable whenever possible. Spring planting is possible with all stocks except those dug for the market, and when winter protection is necessary this practice is always the most economical of space and labor.

Some European growers habitually dig in the fall and store practically all their lily bulbs for spring planting. One grower in this country, operating on a peat soil, finds it advisable to follow this practice with the Regal lily.

## SOIL

The Regal lily succeeds under a very wide range of soil conditions. On Puget Sound at Bellingham, Wash., it grows well on both

drained Whatcom silt and Lynden sandy loams. The development, however, is accelerated very decidedly when planting occurs on the partially ameliorated and well-drained peat soil of the region. Seedlings start off very satisfactorily and grow most vigorously on these peaty deposits and succeed admirably also on the ordinary neutral imported peat commonly sold on our markets.

At Arlington Experiment Farm, Rosslyn, Va., field cultures were attempted on both upland clay and a sandy loam fill. Success was obtained on the latter but not on the former, although the lily does succeed very well on clay loams provided the tillage is deep and good drainage is assured. The failure on clay soil is attributed to lack of water percolation through the soil beyond the plow depth of 10 to 12 inches, giving a water-logged condition, especially during the winter season. The reaction to this condition is more fully discussed on a subsequent page.

## PLANTING AND SOIL PREPARATION

As with practically all lilies, a bed form of planting is advised because of the thick and heavy crop which assists in furnishing its own protection for the soil and obviates the necessity of cultivation near the plants. The Dutch-bed method seems well adapted to the culture of this lily and has been the one employed in the investigations detailed here.

The soil for a lily planting should be very thoroughly and deeply tilled. At Bellingham, Wash., this culture has consisted in plowing to a depth as close to 15 inches as possible. A subsoiler has then been used to break the ground 6 inches below this. An endeavor is made to get as good a tilth as possible by turning under crops of rye and vetch or rotting sod, or by incorporating straw, manure, or any organic material that can be had; but no manure or straw is used within six months of planting time, and a full year is better.

The land is carefully laid off and the end of the plot squared. The beds are laid off with taut lines and marked by cutting the edges deeply 3 feet apart and alternating with 18-inch paths. The soil is thrown out of the first bed to a depth of 4 inches or more. Bone meal at the rate of about 1,500 pounds to the acre applied in the excavated bed is cultivated and raked in. The bed is then marked with rows running crosswise.

If large bulbs of the Regal or any other lily are to be planted and left two years, as is usually the case, the rows are made 9 inches apart. Small-sized bulbs and seeds are planted in rows 6 inches apart, or at times seed is put in 3-inch rows. It will be seen that the planting does not differ except in minor details from that of tulips, daffodils, and other Dutch bulbs. The method is more fully described in another bulletin of this series.[1]

As stated above, the first bed is excavated not less than 4 inches deep. If rather large bulbs of the Regal lily are to be planted, say those 5 to 7 inches in circumference, they are planted seven to nine to the 3-foot row. Usually in planting this lily the bulbs will grade into about three sizes, one above 5 inches, one 3 to 5 inches,

[1] GRIFFITHS, D. THE PRODUCTION OF TULIP BULBS. U. S. Dept. Agr. Bul. 1082, 48 pp., illus., 1922.

and one below 3 inches. The small bulbs are strewn along the rows with no effort at placement and go in from 14 to 35 to the row, depending on the length of time the planting is to stand undisturbed. The second size is set up 11 to the row, and the first size 7 to 9 to the row. In setting the two larger sizes with their roots on, it is necessary to use a strong hand trowel which enables the planter to put the bulbs down so that their noses are flush with the depression in the excavated bed; that is, 3 to 5 inches for the smaller bulbs, and an inch lower than this if the larger size is being planted. It will be seen that the depth of planting is thus accommodated to the size of the bulb, the largest size going in an inch or so deeper than the 4-inch excavation, the middle size just its depth to the tip of the bulb, and the smallest sizes, not placed, have their lower sides just the depth of the excavation, 4 inches or more below the surface of the finished bed. The sizing of the bulbs is done by hand and in all probability always will be. When the first bed has been thus planted the opening of the second bed furnishes soil for covering the first, and the process is repeated as the planting progresses over the entire plot.

In the planting of seed the same method is employed, but the excavation of the seed bed is only about 1¼ inches deep.

## CARE AFTER THE FIRST YEAR

The care of the lily beds the second and third seasons does not differ particularly from that of the first except that it is less burdensome. During the second season at least 25 to 50 per cent of the bulbs form stems. They are much larger in size than during the first season, and if well fed they assist very greatly in protecting the soil with their own shade and also in holding weeds in check. But the fact that the ground is partly shaded does not make a mulch inadvisable. On the contrary, a mulch of old manure will add fertility by leaching and will tend to equalize both temperature and moisture of the soil, two very important elements in all lily culture. Though such mulching material is much the best, if it is not procurable short straw or débris of almost any kind, even though inert, will furnish the necessary protection.

## MULCH AND HARDINESS

The use and benefit of the summer mulch have been discussed. It remains only to discuss the winter mulch as a protection from cold and alternation of temperatures. Whether winter mulching will be really needed for the Regal lily will depend on the nature of the season, where the growing is attempted, and the age of the planting. Seedlings going into the first and second winter undisturbed if undug are shallow, having only about 2 inches of soil over them at most. It has been advised that an inch of soil be thrown over the beds late the first autumn. This is a great protection, and except in very cold or exposed situations is sufficient for this hardy lily.

Whenever more covering is deemed necessary, a dressing of an inch or even less of well-rotted stable manure may be applied in late fall and may be left on if the lumps are well broken up as they thaw

out in late winter. In the absence of manure any débris will serve the purpose. Indeed, when a good covering of snow is certain it is a good protection. Although no apparent winter injury has occurred in either of the experimental situations and the lily has been successfully wintered along our Canadian border, it must be admitted that some growers have had very heavy winter losses in the North.

The species is one of our hardiest lilies. In neither the Virginia nor the Puget Sound region has the writer seen any injury from winter cold, but damage to the tops by late spring freezes has sometimes occurred in both situations. One case has been recorded where a large proportion of the plants were killed outright when the stems, 6 inches or more high, were frozen off. Occurrences of this kind happen occasionally. It is felt that the limiting factor in the production and general growing of this lily will prove to be late spring frosts rather than severe winter conditions.

## DIGGING

The best way to dig the Regal, or any other lily, is by hand, for greater care is necessary than is possible with mechanical means. No better way has yet been worked out than that generally employed in digging Dutch bulbs. The digger, on his knees, works in the dug-over space with a small spade (about 24 inches over all) and takes out one row after another across the bed, as described fully in the bulletin previously mentioned.[2]

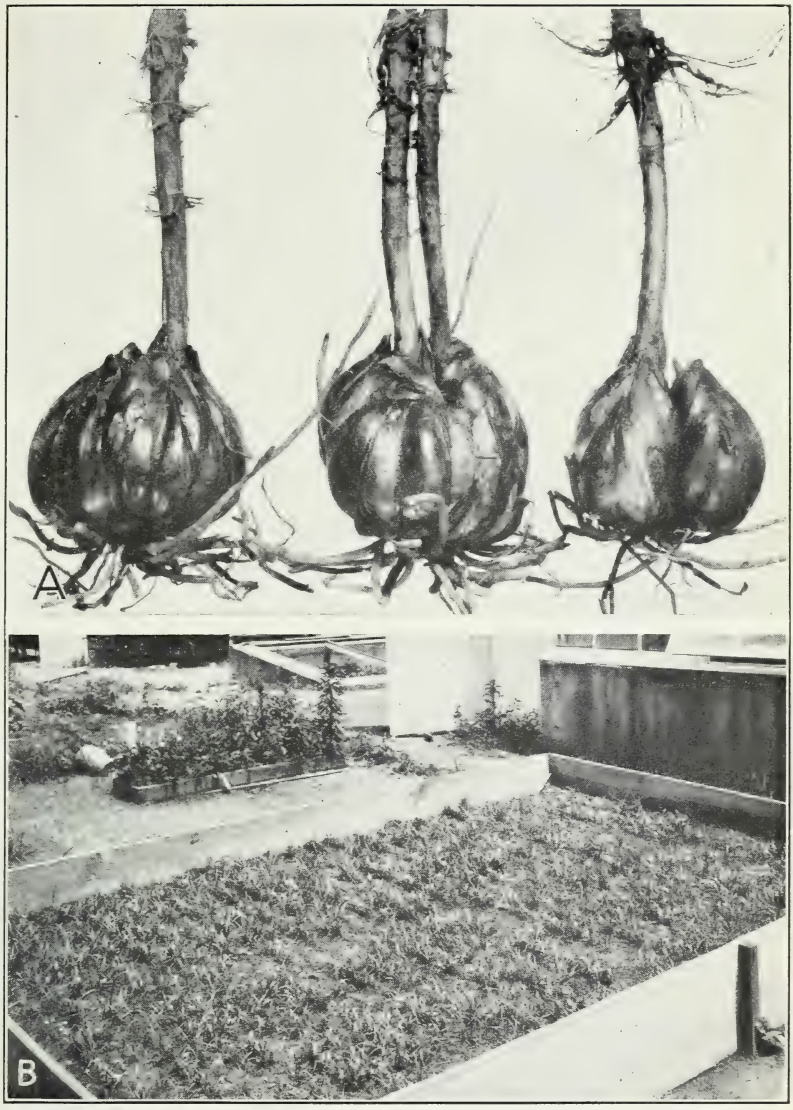
Sometimes a spading fork is employed to advantage. In any well-developed planting of this lily the entire bed is literally filled with the large roots, and many of them are always sacrificed in any method of digging, but probably fewer with a spading fork than with a spade. The least injury is done with the spading fork operated under the plants from the dug-over space, rather than back of the row from the undug portion of the bed.

## STORAGE

The grower should endeavor to keep the bulbs of the Regal and of most other lilies out of the soil as short a time as possible. Bushel lug boxes are as convenient as anything to transport them from the field, and the conventional tray or bulb-house shelf can be used for storage. The bulbs should not be exposed to either sun or drying winds, and drafts in the storage house should be avoided. If handled without bruising, the large bulbs are in little danger of injury even if piled 10 inches high, or if left in the bushel boxes for several days, unless the weather is warm, which is not likely in the North at the season when the bulbs are dug. In the South more care, of course, is necessary.

When for any reason storage must be prolonged, the bulbs of the Regal or of any other lily should be covered on the trays or shelves with dry sand, or, if the weather is dry, they may be covered with dry soil in windrows in the field. The necessary precautions must be worked out for different localities. In a moist

[2] See footnote 1.




## REGAL LILY BULBS AND SEEDLINGS

A.—Progeny of a Regal lily bulb 8 or 9 years of age, after growing undisturbed in a border for six years. Dug late after stem roots had decayed. No stem bulblets were produced. Compare with Plate 4, which represents a seedling of the same bulb

B.—A frame of seedling Regal lilies sown May 23; photographed June 20

THE REGAL LILY IN FIELD BEDS

A.—Regal lily bed 130 feet long in full fruit the middle of September. On the right is a bed of current year's seedlings

B.—The Regal lily in flower the second year from seed sown inside in early winter. Compare Plate 3, A

THE REGAL LILY IN FULL BLOSSOM

A.—Mature bulbs on left. Bulbs in their second year from frame-sown seed sown in May of the previous year on right (see Plate 1, B).

B.—The Regal lily in the ornamental border at the edge of the primeval forest on Puget Sound. The bulbs are 4 and 5 years old from seed

A REGAL LILY PLANT GROWN UNDER IMPROPER CONDITIONS

The bulb fell to pieces with a basal rot when dug, but there were about two dozen bulblets on the stem

maritime location the bulbs will retain their vitality for months in moderately low temperatures when exposed to ordinary atmospheric conditions. In dry situations, however, the sooner the bulbs are smothered with dry earth the better. There is very great difference between the behavior of the bulbs out of the soil at Bellingham, Wash., and at the Arlington Experiment Farm, Rosslyn, Va. They dry out much less in August at Bellingham than they do in November on Arlington Farm.

## REPRODUCTION FROM STEM BULBLETS

Under certain conditions the Regal lily produces an abundance of bulblets on the base of the stem contiguous to and among the surface-feeding stem roots. When the lily is thriving, however, no such reproduction seems to take place. To the writer this form of reproduction has appeared to be a reaction to unfavorable conditions, and it has seemed that the production of these bulblets usually, if not invariably, is an indication of uncongeniality of cultural surroundings.

Plate 1, A, shows the first bulb purchased for these investigations in 1917. This bulb produced no stem bulblets in the six years that it grew in good border soil. A progeny of this bulb, grown on a heavy clay soil worked only about 10 inches deep and underlain by heavy clay, produced an abundance of stem bulblets as shown in Plate 4. On this soil it was not possible to maintain good health in the bulbs. The bases decayed and there was a paucity of normal roots. The development of bulblets seems to be in proportion to the imperfection of the bulbs and in consequence of it.

The stocks, after three years of poor behavior under these conditions, were moved to a well-drained sandy loam soil. They recovered slowly in health, vigor, and growth, and the production of bulblets gradually ceased, until at the last digging they did not average one bulblet to two stems in the lot of 250 bulbs.

On Puget Sound, at Bellingham, Wash., the lily has behaved very satisfactorily on both Whatcom silt and Lynden sandy loams. In both soils the development of beautiful, large, healthy bulbs with no stem bulblets is the rule.

It is likely that the grower has in this stem-bulblet reaction a very good indicator as to the suitability of his conditions to the production of the bulbs. If an abundance of the bulblets is produced, something wrong may be suspected. It may be, as in the writer's case, that this effort to perpetuate the species is a reaction to poor drainage and bad soil conditions, or it may be brought about by other untoward circumstances, such as raw manures too close to the bulbs, causing more or less basal rot.

It is asserted that bulblet production can be accelerated by preventing seed production. This information is given on a suggestion from a very good authority. The writer's experience on this point has not been conclusive. In all cases in the work of the Department of Agriculture, stem-bulblet production has been accompanied by an imperfection in the main bulb.

The first method used to induce the production of stem bulblets was to dig down beside the plant and sever the stem just above the bulb with as little disturbance as possible. This was done when the

plants were in blossom. The result was an abundant production of bulblets by digging time in October.

In the summer of 1925 stem-bulblet production was induced artificially on a considerable scale at Bellingham, Wash. The season was an early one and the species blossomed in mid-July. As soon as the flowers had faded the stock was dug. The stems were cut off close to the bulbs or twisted out and then heeled in in the field with 1 to 4 inches of soil over the lower 12 inches. By September 1 there was a large development of bulblets in the normal positions on the stem, averaging six or more in number, besides a prospect for a small crop of seed, some of which matured. In other words, the stems reestablished themselves readily after this kind of treatment.

## THE BEST WAY TO PRODUCE STOCK

Contrary to the methods used with most bulbous plants, this lily seems to be produced best from seed. Although the vegetative reproduction has received some attention and has been advocated by some, it does not seem to be specially applicable to the Regal lily. It is more than likely that not only this lily but many others will be more and more grown from seed as soon as our propagators learn the advantages of such production and become experienced in it.

Objection has been raised to the variable nature of the seed reproduction. There is considerable variation of a certain kind, involving difference in number of blooms, size of leafage, color of stem, etc., but there are no striking or objectionable variations in the Regal lily such as there are, for instance, in the Easter lily (*Lilium longiflorum*) grown from seed. Differences in color of flower are sometimes pointed out, but even these are mostly aging effects, a bleaching out owing to exposure. The flowers and plants are remarkably uniform, at least sufficiently so for the border, the bed, or the forcing bench. There are no variations here which are in any way comparable with those in long-cultivated horticultural varieties such as are found in forms of *L. longiflorum*. It may be, however, that when other importations are made variability may be obtained. It is well also to remind the reader that the writer's experience is with the progeny of a single bulb self-pollinated the first season.

## FERTILIZERS

The Regal, like many other lilies, is a gross feeder. Especially in heavy plantings such as are advised an abundant supply of plant food in the soil is an imperative requirement for satisfactory production. The bad effect of manures when in contact with the bulbs by no means precludes the proper use of such manures in the culture of this lily. Almost any sort of manure can be applied as a top-dressing when the plants are well rooted. Stable manure so employed has given satisfaction when used rather liberally and in almost all stages of decomposition. Instances are known of practically fresh cow manure being used as a winter mulch and left on during the growing season. A liberal application of manure in the soil six months in advance of planting is usually safe, or the lily can be grown without injury on the residue of fertility from a heavy application of manure for a previous crop of vegetables.

Commercial fertilizers give satisfactory results when properly applied. In the experiments at Bellingham, Wash., fine-ground commercial raw bone meal has worked well. This is almost invariably a safe fertilizer. Here the Dutch method of planting is used with the Regal as well as with other lilies. The beds are excavated to a depth of 4 inches or more, as previously described. The bone meal is applied in the bottom of the depression at the rate of about 1,500 pounds to the acre and then mixed with the soil by running a wheel hoe with cultivator-teeth attachment working from 4 to 6 inches deep about three times lengthwise of the bed. This with subsequent smoothing with a hand rake gives a good mix, and no burning or other injury to the bulbs occurs. It is very likely that in spring planting 1 or 2 per cent of the bone meal could profitably be replaced by tankage, as one grower is now doing with the Easter lily to good advantage. This may not be so advantageous with fall transplanting of the Regal lily.

Less knowledge is available on the use of the ordinary chemicals, but still suggestions based on considerable experience will meet the probable requirements. On Puget Sound decidedly beneficial results have been obtained from the use of acid phosphate alone as a supplement to large crops of rye and vetch turned under on newly cleared forest land. Good results have been had from the use of about a 4–8–4 mixture of commercial fertilizer applied at the rate of 1,500 to 2,000 pounds per acre on the Arlington Experiment Farm. In one case an application in early June to seedling beds set in April using the above formula at the rate of 1,200 pounds to the acre seemed to be very satisfactory. The fertilizer in this case was distributed between the 6-inch rows by hand without allowing contact with the young seedlings and was then washed into the soil.

A chemical fertilizer comparatively high in potash is believed to be necessary for best results. The grower can not go far wrong if he employs the formula which has been worked out as best for potatoes in his region and uses about the same quantity as is commonly applied for that crop.

## SEED PRODUCTION

In order to insure an abundant seed crop in this lily it is necessary to hand-pollinate the flowers, although a considerable natural pollination occurs. It is thought that most of the unaided fertilization is a self-pollination, which is not so effective as cross-pollination.

All the stocks grown by the department are from one bulb which, of course, was self-pollinated the first year. After that promiscuous crossing has been the practice.

How this work is done matters but little. The approved method is to apply pollen to the stigma with a camel's-hair brush, but in a flower with such large parts there is no reason why pollination should not be accomplished by pinching off the anther with thumb and forefinger and brushing the pollen over the stigma of another plant without the use of forceps, brush, or any other tool.

How much influence the production of a seed crop has on the development of the bulb crop has not been determined, but it is well recognized that in the tulip and many other bulb genera better yields are obtained when seed production is prevented. The same

is probably true with the lilies. For the present, however, this point may not be very important, for seed production to the limit will be necessary for some years if stocks are to be developed to supply the market. When this has been accomplished there is little doubt that removal of the flowers from stocks intended for market the following autumn will be practiced generally by the best growers. In the work done by the department thus far, few flowers have been removed, because a maximum crop of seed was desired. This must be taken into account in any estimate of production based on the experiments detailed here.

The yield of seed in this lily is phenomenal under favorable conditions. The plants commonly produce five well-filled pods containing anywhere from 300 to 600 or more fertile, viable seeds. In the season of 1925 two beds occupying a space 3 by 130 feet each, as shown in Plate 2, A, yielded about 6 pounds of heavy cleaned seed. These beds, including the two 18-inch paths, measure about one-thirty-sixth of an acre. An average run of viable, well-filled seed will contain approximately 65,000 to the pound, a much smaller number than a pound of seed of *Lilium longiflorum*, which has about 102,000. The Regal lily is one of the heavier seeded species.

## THE HABIT OF THE REGAL LILY

Under glass the Regal lily stands in the pots 24 to 36 inches over all and is much more uniform than Formosum but less so than Giganteum.[3] The leaves are narrow and delicate and the stems commonly, but not always, rather weak for a heavy truss of flowers. Staking is very often necessary unless the plant is grown with ideal lighting.

Under field conditions in the Virginia location the plants stand about 30 inches high and very uniform all over the beds. (Pl. 2, B, and pl. 3, A.) At Bellingham, Wash., however, on Whatcom silt loam with little or no mulch and under open field conditions, the lily has seldom been over 2 feet high and the stems not so strong as in the Virginia region.

It is a peculiar thing that the plants most likely to need staking are those with few flowers. The largest trusses usually have a proportionately larger stem to support them, and commonly the flowers are better balanced.

In the ornamental border the habit of the lily is very different. It is commonly 4 or 5 feet high and 6 feet is not at all unusual. Under such conditions, unless it is supported at the base by surrounding vegetation, staking is necessary, especially if winds are severe. However, the stems are very wiry, and although bending over considerably, it is seldom that they fall prostrate. (Pl. 3, B.)

## LONGEVITY

The Regal lily is long lived. How long it endures the writer does not know, but he is of the opinion that it is indefinite in lease of life of the individual plants. The first bulb grown by the writer was probably 3 years old and was procured in 1917. It was planted in a

[3] These are varieties of *Lilium longiflorum*.

border and was not disturbed until 1924. In the six years it had split into three double-nosed bulbs and was still going strong. (Pl. 1, A.) Some of the first crop of seedlings from seed raised in 1918 are still being grown, but large bulbs have several times been removed from the lot. During last season the whole lot of bulbs of this progeny grown at Bellingham, Wash., measuring 5 to 9 inches in circumference, was closely scaled for further investigations.

## PESTS

No pests of consequence have been encountered thus far in the culture of the Regal lily. Mention has been made of the inroads of the ubiquitous damping-off fungus in seedlings. This is controlled by care in watering and good aeration. Spraying with the recently developed mercurial compounds will assist.

As is the case with many bulbous stocks, the pests are mostly man-made, but fortunately the Regal resists these also more effectively than most lilies. For instance, the lily rust (*Uromyces lilii* Clint.), so destructive to the Madonna lily and the American lilies generally, seldom produces pustules on the Regal even when surrounded by a heavy infestation in other lilies in close proximity.

Diseased condition in the lily is frequently brought about, as has been pointed out, by improper handling. Any appreciable quantity of manure, even if well rotted, incorporated with the soil close to planting time or stagnant moisture over a dense impervious subsoil will be likely to produce an alarming diseased condition accompanied by an abundance of organisms such as the bulb mite, which assist in the progress of basal decay. The remedy is manifestly to correct the cultural conditions.

Allowing the bulbs to heat in piles or in the pack or permitting too great desiccation also induces rotting which may be mistaken for parasitism.

## THE REGAL AS A FORCING LILY

The essentials of the handling of this lily under glass so as to flower it at any stated period, particularly for Easter, can be told in few sentences. Its handling is simplicity itself, but there are as usual some requirements that must be met.

The bulbs should remain out of doors until January 1. They should then be put on the benches in a temperature of 60° F. at night and should be kept at this temperature until they flower. They will begin to show top growth in 10 days and to develop tops and bottoms at the same time. No experience has been had in the forcing of bulbs grown at Bellingham, Wash., but Virginia-grown bulbs have been forced for a number of years, always with success when handled as directed above.

In the climate of Washington, D. C., it is preferable to leave the bulbs in the field until January 1. Occasionally there is a little delay caused by the ground being frozen, but it is seldom that digging can not be done some time between the middle of December and the middle of January. The bulbs are dug, potted up, and put immediately into a temperature of 60° F. at night.

It is fully realized that in many locations it may not be practicable for obvious reasons to leave the bulbs undug until midwinter.

When merchandising for forcing purposes such handling is not feasible, but there is no difficulty in handling the bulbs in ways very comparable with what obtains now with the Easter lily, leaving the bulbs in storage until late December or early January.

There is no lily bulb that handles more easily and keeps better than the Regal. On two occasions small quantities of the bulbs have been stored in dry sand in a frostless, slightly heated cellar room, once from October and once from New Year's to April, with good results. On another occasion bulbs dug in mid-September were stored in open boxes at a temperature of 36° F. until November 1, when they were in perfect condition.

Bulbs of this lily received in the fall and intended for forcing can be handled satisfactorily in several ways. They may be potted up right away, kept on the dry side, and set away in the heeling ground, either buried or covered so as not to freeze, until the first of the year, when they can go directly into heat. If more convenient, the bulbs can be held in cold storage at a temperature of 34 to 36° F. awaiting the time for potting and forcing, or they may be buried in dry earth and held in a dry, rather low-temperatured situation until potting time.

Potting the bulbs October 1 and subjecting them to even a moderate temperature of 50° F. at night has given uniformly poor results. One season several hundred bulbs were divided into two lots and placed in two greenhouse units, one held at 50° F. at night until the first of the year, and the other started under the same conditions and then run up to 60° F. The two lots started top growth close to the same date, but a very large percentage of the bulbs in the higher temperature failed entirely. They rotted in the pots so badly that only a small percentage blossomed at all. The lot held at the lower temperature was transferred to the 60° temperature in late January. They did better, but were far from satisfactory.

The Regal lily is very different in some of its habits from the Easter lily (*Lilium longiflorum*). It must have its period of rest after the season's growth, whereas *longiflorum* can be handled almost as an evergreen under some conditions. Even seedlings of the Regal before the flowering stage become dormant in fall when heat and moisture conditions are favorable.

An attempt was made one year in the early part of these investigations to continue the growth of first-year seedlings into the winter, which can be so well done with *longiflorum*. The seedlings which were started in flats November 1 were pricked off into 2-inch pots in January and then planted in beds in the field in April. They were well handled during the summer and made a very good growth. With tops carefully preserved they were transplanted into 4 and 6 inch pots October 1. After a period in which they were kept cool to become reestablished in the pots they were gradually inured to a temperature of 55 to 60° F. by January 1 and held so until early February. They remained partially green, but no growth of herbage took place, and the older leaves gradually yellowed, so that there was little top left by February. As it seemed impossible to get action inside, the entire stock of 750 bulbs was moved into a frame and covered with straw, and there it remained, making fairly good root development, until early in April, when the plants were knocked

out of the pots and reset 6 inches apart each way in the field. The following fall, when the batch of seedlings was 23 to 24 months old, it was gratifying to see that the bulbs had attained a size of 5 to 9 inches besides producing 5 pounds of clean seed. This is the largest size that has been attained in two years' growth. The point to be noted particularly here is that the lily, even in the seedling stage before it has flowered, wants to go dormant in fall; that is, it requires a period of rest before normal vigorous growth will take place again. This has an important bearing on the methods which must be used in forcing it.

It has been rather surprising to note the rapidity with which the lily responds at proper seasons and the degree of heat which it will endure. One year a batch dug from the field in late December was divided into three lots, which were placed in three separated greenhouse units, one at 50 and one at 60° F. night temperatures, and the other at a constant temperature of 70 to 80° F. In the higher temperature the plants developed very rapidly. Only 2 out of 36 did not blossom, and they threw up stems with no buds. All the flowers in this lot opened within five days of one another, and the last flower was open 65 days from potting. At this time the stocks in the lowest temperature were not over 2 inches high, and some were just coming through the soil. Those in a temperature of 60° F. at night were intermediate.

This test is important in that it throws further light on what the lily must have in order that it may come along rapidly, vigorously, and most economically under glass. The flowers at the high temperature, as would be expected, were "soft" but fully up to quality in size and coloration. A temperature of 60° F. at night, it has been found, produces normal flowers of good quality in about three months' time, depending, of course, upon the usual factors of light, sunshine, watering, etc.

Either large or medium sized bulbs may be successfully forced. The larger sizes can go into 6-inch and the smaller into 4-inch pots. The former make the most handsome and satisfactory specimen plants. The latter may be matched and several plants assembled at flowering time in an 8 or 10 inch pot with a little trimming to make a piece which can scarcely be surpassed in lily decorations.

## THE REGAL LILY IN BEDS AND BORDERS

No discussion of the Regal lily would be considered adequate without some reference to its use in garden decoration. Little consideration of this phase is necessary, however, for its praises have been sung sufficiently from this viewpoint for the last 10 years or more. Its ease of reproduction, its wide adaptability, and its convenience of handling should make it as conspicuous around the American home, if the growers do their duty, as is the Madonna lily in the cottage gardens of the British Isles. As a garden decoration it has scarcely a peer, unless it be a well-grown specimen of the Goldband lily.

The span of decorative usefulness of the flowers on Puget Sound is approximately three weeks in the garden, and this can often be prolonged to a month by employing different exposures. In the climate of Washington, D. C., the period of usefulness is shorter,

occurring from late June to early July. On Puget Sound in average seasons flowering takes place three or four weeks later, in the latter half of July.

## THE REGAL LILY AS A CUT FLOWER

Its grace, beauty, and keeping qualities adapt this lily well to cut-flower purposes. When cut in the well-advanced bud stage it opens nicely in vessels of water when brought into living-room conditions. It has all the good qualities of a cut-flower lily. The flowers are tough and leathery, last well in water, and have an agreeable fragrance without, however, the offensive heaviness usually attributed to the Goldband species. Like the Easter lily (*Lilium longiflorum*), it seems to be best cut for immediate use when the first bud has expanded.

## TRANSPLANTING

As with most lilies, the Regal is not difficult to transplant in vegetative condition. The transplanting of young seedlings to small pots or flats, from them to the field, and from the field back into large pots has been described. On another page was also briefly discussed an instance of lifting the plants immediately after the flowers had faded, cutting off the bulb, and then heeling the stem in, 1 foot deep, in the usual slanting position. The stems thus handled become sufficiently reestablished not only to keep alive but to produce a crop of bulblets and a small crop of seed. Certainly no one could ask more of a plant than this. There is usually no occasion for moving the lily except during dormancy, but with care it can be accomplished at almost any time and as easily as with almost any perennial.

## TRANSPORTATION OF SEEDLINGS

The transportation of seedlings by mail or express at any time during the development of the second leaf or thereafter is easily accomplished by the same methods as described in Department Bulletin 962.[4] The young plants are carefully removed from the flats and laid in smooth, even piles of about 200 each. Each pile is then placed on a ribbon of sphagnum moss reaching only to original ground level and from which as much water as possible is squeezed out by hand. The whole is then rolled tightly in oiled paper and tied. Several of these rolls may be put together in a mail package, in cartons, or rolled in strips of corrugated board for shipment. Several wrappings of newspaper and wrapping paper on the outside of the board make very good insulation against any low temperatures to which the plants may be subjected.

The young seedlings may also be wrapped tightly in newspaper or in oiled paper and this package wrapped in sphagnum as described in Department Circular 323.[5] This seems to be a really safer method than the former.

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[4] GRIFFITHS, D. THE PRODUCTION OF THE EASTER LILY IN NORTHERN CLIMATES. U. S. Dept. Agr. Bul. 962, 31 pp., illus. 1921.

[5] GALLOWAY, B. T. HOW TO COLLECT, LABEL, AND PACK LIVING PLANT MATERIAL FOR LONG-DISTANCE SHIPMENT. U. S. Dept. Agr. Circ. 323, 12 pp., illus. 1924.

## SHIPPING THE BULBS

It is more than likely that the transportation of domestic-grown bulbs of this and other lilies will be done mostly by express. It will therefore be necessary to simplify and lighten the pack as much as possible. This will not be difficult to do for a maximum of a week's journey in cool weather, for the stocks will usually be dug in October.

The bulbs will carry nicely if they are wrapped individually or in twos or threes, in a sort of butcher's package in news or other paper, and packed tightly in boxes holding a bushel or more. If there is danger of drying out too much, a little barely moist sphagnum may be added thinly between the different layers of packages.

If shipping is done by freight it will be necessary to pack in tight boxes in dry earth, as is now done with imported lily bulbs of various species. It is probable, however, that little economy will be effected in freight over express shipments when the added weight of the packing soil is paid for.

Whenever a large quantity of small bulbs is to be shipped, only a slight modification of the first method of packing is necessary. The bulbs may be wrapped in the same way, in handfuls or small quantities, may be put into small paper bags and these packed in boxes either with or without the moist sphagnum between the packages.

In the Puget Sound region an abundant supply of peat of excellent quality for packing purposes is to be had to lighten the pack, if it is desired to simulate the handling of the imported bulbs. Of course, imported peat can be used, as it is now available at a reasonable price nearly everywhere, but it is felt that even this small additional expense is not necessary.

## TO CUT OR NOT TO CUT THE ROOTS

To the forcer who is accustomed to the trim, neat, imported Japanese lilies the copious ragged mass of roots adhering to the bulbs may not appeal; but experience seems to indicate that, although a good performance is to be expected from bulbs with the roots cut close, there is an advantage in preserving the roots when this is practicable. The value of the roots, however, will depend upon whether they can be kept and gotten into their new growing quarters alive and in shape to function. If badly dried out or bruised and molded in spots they had better be cut off; but if reset in good condition, even if somewhat withered, they will reestablish from adventitious buds which strike out several inches from the bulb and frequently the entire root will live and reestablish itself. This applies particularly to outdoor planting. When, as is so often the case, the large mass of roots if retained must be wadded into the pots, it is better to cut them back to 2 or 3 inches in length. The roots reestablish much more readily under field conditions than in pots in the greenhouse.

Of course, the expense of handling must be considered in this matter. The mass of roots from the base of the bulbs is bulky and heavy if preserved in a way to function and be of any value. The added weight in shipping and the added difficulty in handling

and packing when the roots are attached is considerable and must be evaluated in a decision on whether to cut or not to cut.

It is a little difficult to pot up the bulbs with roots on, especially if one wishes to get them into the smallest pots possible, which is always advisable. The roots are bulky and for the most part must be wadded into or close to the bottom of the pot, but those not bruised recover in whole or in part and continue to function.

## SUMMARY

The Regal lily, like many others, is most easily and satisfactorily produced from spring-planted seed.

If well grown, the seedlings will give some normal blossoms the second year, and will blossom full the third, when the bulbs should reach a merchantable size of 6 to 9 inches in circumference.

The seed, planted one-fourth to 1¼ inches deep, may be started in flats in the greenhouse, in frames, or, with care, in the open field.

Stem-bulblet production seems to be induced by unfavorable cultural conditions and apparently is associated with poor bulb development.

The bulbs are best transplanted in the spring, but may be handled also in the fall. They may be stored in any dry, frostless situation, in dry earth, or they may be carried in cold storage.

When handled under glass the bulbs may best be allowed to take a large measure of the weather up to January 1 at least; they should then be put directly into a heat of 60° F. at night until they flower, which will be in about three months.

The Regal lily is remarkably free from pests, is well adapted to a neutral or slightly acid soil, requires heavy fertility, can be manured (provided none of the manure comes near the bulb), responds readily to commercial fertilizers, and is as amenable to commercial requirements and as adaptable to varying conditions of handling and soil as any lily known.

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December 7, 1926

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